284

LIMITED CIRCULATION

This paper is not an official document: it is for information only and must not be quoted in any printed publication

Agricultural Memorandum No. 1025

DEGREE-DAY/T-SUM LAPSE RATES IN THE WELSH HILLS

by C P Roe

Summary

Degree-days above a base of 0°C were measured using a battery-operated temperature integrator at a hill top site at Trawsgoed near Aberystwyth, mid Wales. Totals recorded over a 62-day period in early 1984 were compared with those estimated from screen thermometers at a lowland meteorological station nearby. The degree-day totals at the lowland site corresponded very closely to the T-sum totals; this also applies to the upland site (although no measurements were taken to substantiate this). A daily lapse rate of approximately 0.5 degree-days or °C per 100m was recorded for degree-days >0°C and T-sums respectively. This is not significantly different from the standard altitude correction of 0.6°C per 100m used in the Meteorlogical Offices' T-sums service.

1. Introduction

The Meteorological Office T-sums service described by Hume (1983) and Roe (1984) provides weekly T-sum estimates, plus a correction of altitude, for 40 km squares covering England and Wales. The height correction is based upon a mean temperature (and hence T-sum) lapse rate of 0.6°C per 100m for days when the mean temperature exceeds 0°C.

The setting up of a hill top met site during June 1983 at Trawsgoed which was some 210 metres higher but only 1 mile distant from the official Trawsgoed meteorological station, presented an ideal opportunity to test the validity of the height correction used in T-sum estimates. This paper presents the results of a simple trial conducted during January February and March 1984.

2. Siting and Equipment

The two sites chosen for the experiment were:-

a. Trawsgoed meteorological station, height 61m, NGR 2674 2736. The site lies in a frost hollow at the base of a W-NW'ly facing hill slope forming the side of the Ystwyth Valley. It is particularly exposed to winds from a SE thro' W to N'ly direction.

b. Trawsgoed upland site, height 270m (approx) NGR 2689 2733. The site is on an exposed hill top with little or no protection from the prevailing winds.

Initially Edale battery-operated temperature integrators and probes (as described by Roe, 1981) were installed in Stevenson screens at both of these sites. However the integrator at the lowland site soon became faulty when damp penetrated its electrics, so standard maximum/minimum thermometers had to be relied upon to provide the degree-day (and T-sum) figures. The upland integrator was usually read weekly while the maxima/minima at the lowland site were read by Mr John Lewis, the met observer.

FH2B

3. Calculations

These are complicated by two factors:-

a. failure of the lowland integrator prevented direct comparisons of integrator readings at the upland and lowland sites. Instead degree-days had to be estimated from screen max and min using empirical formulae which will produce different estimates from what the integrator would have recorded. However from the few readings which were available before the integrator stopped, it appears that the difference is very small and so it has been ignored.

b. Degree-days $>0^{\circ}C$ (from screen max/min) differ from T-sums when the minimum temperature falls below zero. At the lowland site after 62 days, the difference was 2.7%, with the degree-day total larger than the T-sum total. (Appendix 2). It is difficult to estimate the upland T-sum from integrator recordings but the difference is likely to have been small due to the infrequent sub-zero temperature. With this reasoning one can assume that the lapse rate for degree-day $>0^{\circ}C$ also applies to T-sums.

The formulae used to calculate degree-days and T-sums are given in Appendix 1.

4. Results

The daily degree-day/T-sum increments (calculated from screen max/min at the lowland site) and integrator readings are shown in Appendix 2. On 4 March the degree-day totals at the lowland and upland sites were 286 and 218 respectively. This gives a degree-day and hence T-sum lapse rate of 0.52 degree-days or $^{\circ}C$ per 100m per day. The lapse rate was the same for January and February.

5. Conclusions

The results of the simple trial carried out here suggest a slightly different T-sum lapse rate of $0.5^{\circ}C$ per 100m rather than the assumed rate of $0.6^{\circ}C$. However bearing in mind that the Met Office T-sums service provides weekly height corrections, rounded up to the nearest whole number, there would seem to be little advantage from employing this correction specifically for Wales.

6. Acknowledgements

Thanks go the the met observer Mr John Lewis (and deputies) for taking measurements and for putting up with the inconvenience of clumsy instrumentation in the Stevenson screen. The advice of Dr J Starr in all aspects of the work is gratefully acknowledged.

7. References

Hume, C J (1983) A comparison of the routine T-sum services of the Meteorological Office and of Farmers Weekly in 1983. Agricultural Memorandum No 1008+.

Roe, C P (1981) Degree-day measurments using an automatic temperature integrator. Agricultural Memorandum No. 932+.

Roe, C P (1984) A comparison of on-site observations of T-sums in Wales with those estimated from Meteorological Office maps. Agricultural Memorandum No. 1024.

Any comments or suggestions on this paper should be addressed to the author.

Regional Agro-meteorological Department
WOAD, Trawsgoed
Aberystwyth
Dyfed SY23 4HT

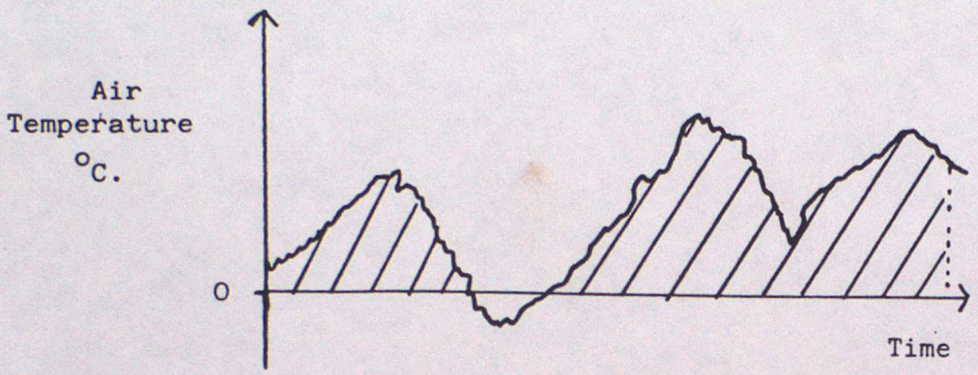
June 1984.

Copies available from the National Meteorological Office Library, Met Office, London Road, Bracknell, Berks.

APPENDIX 1

1. Calculation of degree-days above 0°C

a. Integrator



Area under the temperature curve (////) is continuously integrated.

b. From daily max/min

The four possible cases are:-

Case	Degree-day total
$N \leq 0$	½ (X +N). ie = T-sum
$X \geq 0$	0
$X > 0$ and $X > (0-N)$	½ X - ¼ (0-N)
$N < 0$ and $X < (0-N)$	¼ X

X = daily maximum temperature °C

N = " minimum " °C

2. Estimation of T-sum

$\Sigma \frac{(\text{Max} + \text{min})}{2}$ for days when mean temperature exceeds zero.

APPENDIX 2

1984		Degree -Days	T-sum	Integrator Lowland	Integrator Upland			Degree Days	T-sum	Integrator Lowland	Integrator Upland
January	3	4.2	4.2				3	152.9	149.9		
	4	10.3	10.3				4	161.1	158.1		
	5	16.3	16.3				5	165.5	162.5	*	125
	6	23.8	23.8				6	172.1	169.1		
	7	29.7	29.7				7	178.6	175.6		
	8	34.1	34.1	32	24		8	185.1	182.1		
	9	38.1	37.2				9	189.6	186.6	*	144
	10	42.8	40.9				10	194.0	190.8		
	11	52.6	50.7				11	201.7	198.5		
	12	60.2	58.3				12	207.9	204.7		
	13	66.7	64.8				13	211.0	207.2		
	14	70.6	68.7				14	215.0	210.3		
	15	74.8	72.9	76	57		15	219.3	213.4		
	16	82.2	80.3				16	222.3	216.4		
	17	86.2	84.3				17	227.5	221.6		
	18	90.2	88.3				18	232.1	226.2		
	19	91.3	88.3	89	66		19	235.4	229.5	*	179
	20	92.1	88.3				20	238.8	232.9		
	21	94.5	90.5				21	243.8	237.9		
	22	97.1	93.1	97	72		22	248.6	242.7		
	23	100.4	96.4				23	253.2	247.3		
	24	102.5	98.5				24	254.1	248.0		
	25	104.9	100.9				25	254.6	248.0		
	26	107.1	104.1				26	256.3	249.4		
	27	111.6	108.6				27	259.6	252.7	*	193
	28	116.1	113.1				28	262.1	255.2		
	29	121.0	118.0	117	90		29	265.4	257.8		
	30	125.5	122.5			March	1	271.3	263.7		
	31	130.6	127.6	125	99		2	275.6	268.0		
February	1	137.0	134.0				3	279.8	272.2		
	2	144.9	141.9				4	286.4	278.8	*	218

* Recordings not made due to the instrument getting damp.